

WHAT IS CLAIMED IS:

1. A field-emission electron source element comprising:  
a cathode substrate;  
5 an insulating layer that is formed on the cathode substrate and has an opening;  
a lead electrode formed on the insulating layer; and  
an emitter formed in the opening;  
wherein a surface layer of an electron emitting region of the emitter  
10 is doped with at least one reducing element selected from the group consisting of hydrogen and carbon monoxide.
2. The field-emission electron source element according to claim 1,  
wherein the emitter is formed of a material containing silicon.
- 15 3. The field-emission electron source element according to claim 1,  
wherein the emitter is formed of metal, and a thin film containing silicon is formed on a surface of the metal.
- 20 4. The field-emission electron source element according to claim 1,  
wherein the surface layer has a thickness of 5 nm to 30 nm.
5. The field-emission electron source element according to claim 1,  
wherein the doping with the reducing element is carried out by ion doping.
- 25 6. The field-emission electron source element according to claim 1,  
wherein the doping with the reducing element is carried out by plasma doping.
- 30 7. An image display apparatus comprising the field-emission electron source element according to claim 1.
8. An image display apparatus comprising:  
a vacuum container;  
35 an electron gun disposed inside the vacuum container;  
a member for deflecting an electron beam emitted from the electron gun; and



a phosphor layer provided at a position facing the electron gun;  
wherein the electron gun comprises the field-emission electron  
source element according to claim 1, and

the image display apparatus comprises a system for controlling an  
5 atmosphere inside the vacuum container to be an atmosphere having a  
reducing effect on a material for the emitter of the field-emission electron  
source element.

9. An image display apparatus comprising:  
10 a vacuum container;  
an electron gun disposed inside the vacuum container;  
a member for deflecting an electron beam emitted from the electron  
gun; and  
a phosphor layer provided at a position facing the electron gun;  
15 wherein the electron gun comprises a field-emission electron source  
element having an emitter, and  
the image display apparatus comprises a system for controlling an  
atmosphere inside the vacuum container to be an atmosphere having a  
reducing effect on a material for the emitter.

20 10. The image display apparatus according to claim 9, wherein the  
system for controlling the atmosphere is formed of a material containing a  
hydrogen absorbing material.

25 11. The image display apparatus according to claim 10, further  
comprising a heater disposed in the vicinity of the material containing the  
hydrogen absorbing material.

12. The image display apparatus according to claim 10, wherein the  
30 hydrogen absorbing material contains at least one selected from the group  
consisting of a carbon nanotube, a graphite nanofiber and other carbon  
materials.

13. The image display apparatus according to claim 10, wherein the  
35 material containing the hydrogen absorbing material is an electrically  
conductive material provided inside the vacuum container.



14. The image display apparatus according to claim 10, wherein the material containing the hydrogen absorbing material constitutes a grid electrode of the electron gun.